Six samples of foundry coke from ovens in Alabama contained 0.022 to 0.041 percent phosphorus. An appreciable quantity of vanadium was found in a sample of coal from the Sillapata bed in Peru, South America. The ash of this coal contained 6.9 percent V_2O_5, which was equivalent to 0.95 percent in the coal, as received. Small quantities of vanadium also were detected in two other coals from Peru.

Analysis of a high-ash boghead-cannel coal from Quincy, Mo., proposed for use as a fertilizer material if high in potash, showed less than 1 percent potassium oxide. Three samples of experimental low-temperature coke made from coal to which sodium carbonate had been added to make activated coke were analyzed for carbon dioxide. Most of the carbonate remained unchanged during the coking period and accumulated largely in the finer sizes of coke. Fusain in a tipple sample of Hiawatha-bed coal from the King mine, Carbon County, Utah, was determined by the chemical oxidation method to be 1.7 percent on an as-received basis.

Other materials analyzed included a sample of roof shale from the underground gasification of coal project at Gorgas, Ala., a heat-retaining substance containing charcoal for covering ingots, a corrosion deposit from a Koehler lamp, copper sheet metal used in explosives research, sodium and gold chloride used as a standard in X-ray analysis, a liquid incendiary bomb that had been made from a light bulb, and furnace-black grit from a carbon-black plant in Texas.

Reflectance of Coal

A preliminary investigation was made of the method of quantitative petrographic analysis of coal proposed by Dr. C. A. Seyler in England and based on apparent discontinuous variations in reflecting power of the micro-constituents of coal. Seyler has set up a series containing nine steps of reflectance, ranging from 0.26 to 4.41 percent, and he states that the micro-constituents of coal, excluding spores and cuticles, have reflectance values varying discontinuously in the steps of this series, with the lowest values in vitrain and the highest in fusain. Approximately 200 reflectance determinations were made with a Berek microphotometer on each of two polished-coal blocks, one from a bright coal and one from a splint coal. Frequency graphs of the various observed reflectance values did not show maxima coinciding with Seyler's reflectance series. It was concluded that a more critical test of the Seyler method must await delivery of better equipment.

Electron Microscope Studies of Metal Fumes and Fischer-Tropsch Catalysts

The ability of the electron microscope to reveal characteristic crystalline shapes and sizes far beyond the power of the optical microscope was emphasized by study of several specimens. Figure 1 shows an electron micrograph of chromium fumes, examined along with other metal smokes in connection with health studies. There were extremely thin hexagonal crystals and very fine globular particles, as small as 20 angstroms (0.000002 millimeter) in diameter, very near the limit of resolution of the electron microscope.

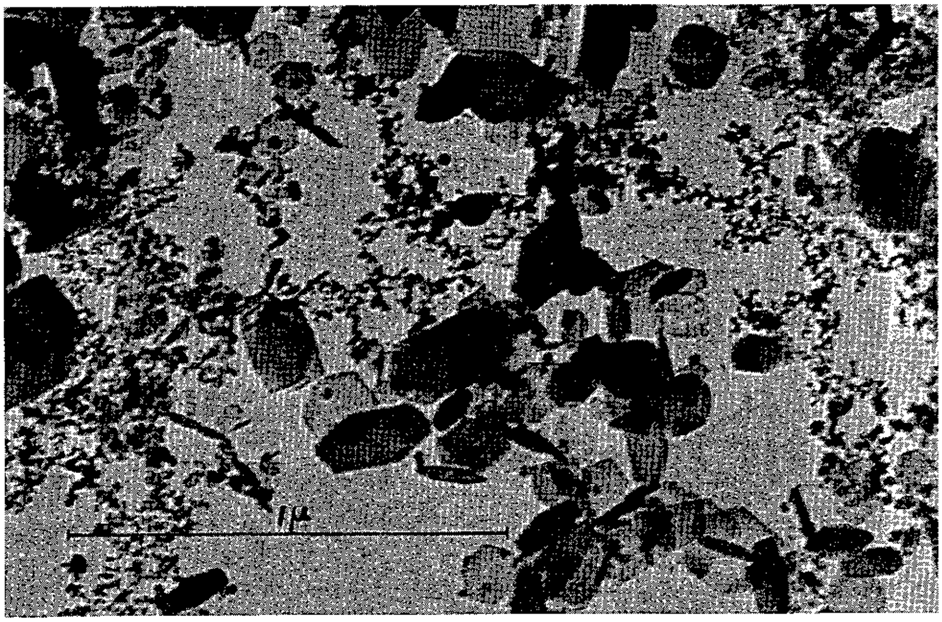

Figure 1. - Electron micrograph of chromium fumes.

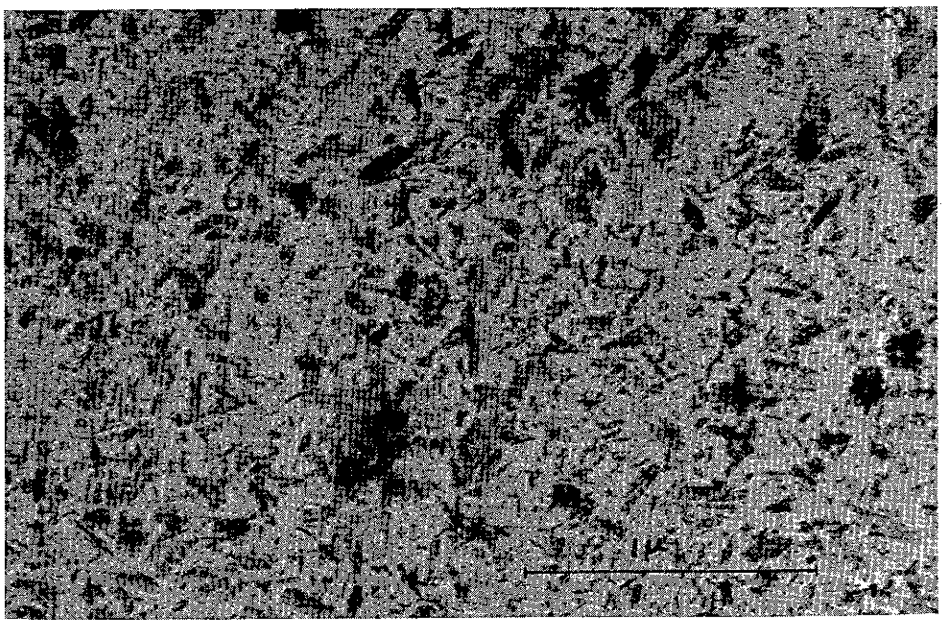

Figure 2. - Electron micrograph of copper oxide.

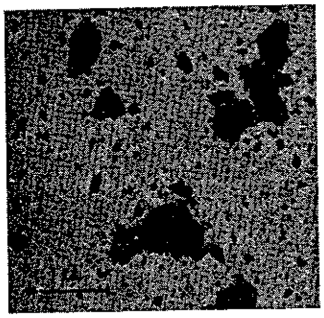

Figure 3.

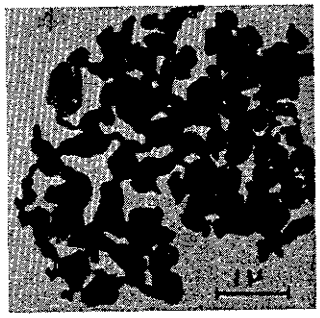

Figure 4.

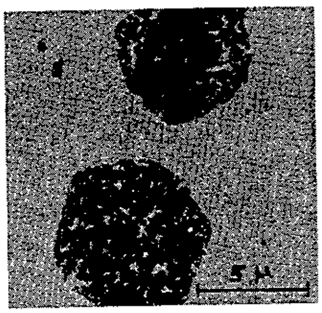

Figure 5.

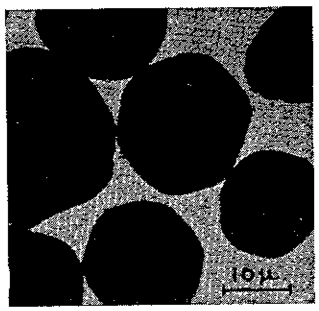

Figure 6.

Figure 3. - Electron micrographs of cobaltous oxide.

Figures 4-6. - Electron micrographs of cobalt metal reduced from cobaltous oxide, in various stages of dispersion.

Figure 7. - Electron micrograph of cobalt basic carbonate.

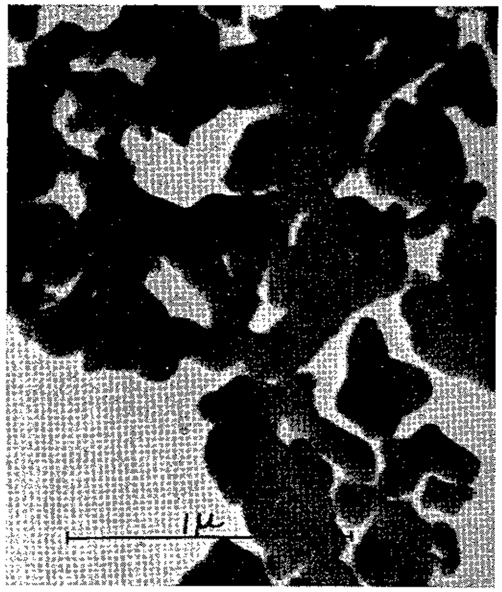

Figure 8. - Electron micrograph of cobalt reduced from cobalt basic carbonate.

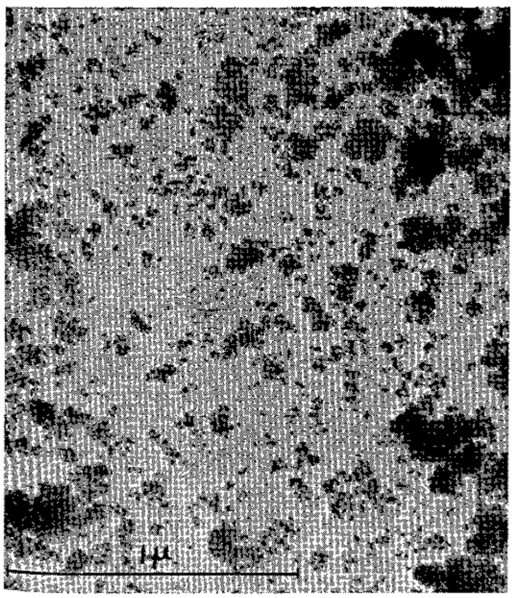

Figure 9. - Electron micrograph of cobalt reduced from cobalt basic carbonate in the presence of thoria and magnesia.

Figure 10. - Electron micrograph of cobalt reduced from cobalt basic carbonate in the presence of kieselguhr.

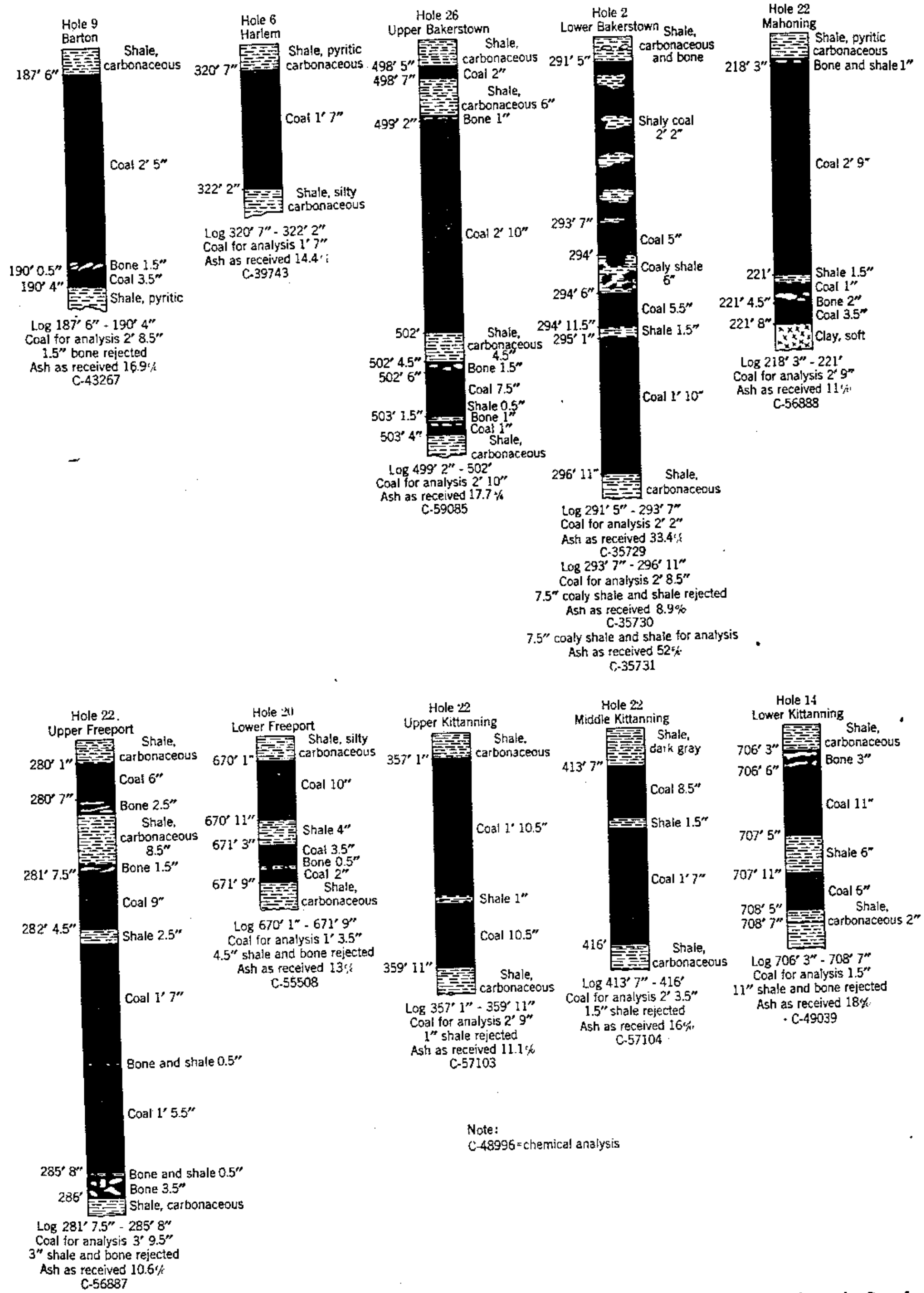

Figure 11. - Typical coal sections of drill cores from the Georges Creek Basin, Allegany and Garrett Counties, Md.

Figure 2 shows a micrograph of copper oxide, used in catalysts for Fischer-Tropsch synthesis. The needle- or plate-like crystals are as small as 70 angstroms in length and 20 angstroms in width.

An interesting phenomenon was observed in cobalt metal powder reduced from cobaltous oxide used in Fischer-Tropsch catalysts. The oxide particles sintered into larger smooth droplets of cobalt that were aggregated into thin, hexagonal-shaped platelets. Figure 3 shows the oxide and figures 4, 5, and 6, various states of dispersion of the metal particles. The hexagons vary in diameter from 7 to 25 microns and their thickness is apparently of the order of the diameter of the component particles. X-ray diffraction analysis also shows that the crystal phase present is hexagonal cobalt. These hexagonal aggregates may be formed by forces similar to those operating in normal crystal formation, but since the component particles do not lose their identity and the aggregates are easily fractured, they can hardly be classed as true crystals.

Electron micrographs have revealed the effects of the presence in catalysts of promoters, such as magnesia and thoria, and of carriers, like kieselguhr, in inhibiting the sintering of cobalt on reduction, thus preserving a large proportion of the surface area upon which the catalytic activity is so dependent. Figures 7 and 8 show the sintering effect when cobalt basic carbonate is reduced alone. This behavior is similar to that of the reduced cobaltous oxide except that hexagonal aggregation is not observed here. Figure 9 shows the much smaller particle size of the cobalt that results when the reduction is carried out in the presence of the promoters thoria and magnesia. Figure 10 shows that the addition of a kieselguhr carrier also decreases the size of the cobalt particles. Measurements on the micrographs give the following average particle sizes: Cobalt basic carbonate, 0.01 micron; reduced cobalt basic carbonate, 0.22 micron; reduced carbonate and promoters, 0.011 micron; reduced carbonate and kieselguhr, 0.028 micron. Surface area measurements by a nitrogen adsorption method confirm this beneficial behavior of promoters and kieselguhr.

Petrographic Studies of Coal

Petrographic analyses were made of selected portions from approximately 414 feet of cores from four test-drilling projects and the results used to correlate drill-log information and to selectively sample the coal for special chemical and physical tests. These cores were from the drilling projects at the Georges Creek field, Md.; Coal Creek area, Colo.; Coosa field, Ala.; and the Castleman basin, Md. Descriptive columnar sections which represent typical coal cores from the Georges Creek, Md., project are shown in figure 11.

Petrographic analyses were made of coal representing eight commercial coal beds from an 8-inch core recovered in test hole 5-33, Minnesota Creek area, near Paonia, Colo. Data showing depth, thickness, and petrographic composition of these coal beds are given in table 2.

TABLE 2. - Petrographic analyses of eight coal beds in test hole 5-33, Minnesota Creek area, near Paonia, Colo.

Depth to coal bed		Thickness of coal		Percent			
Feet	Inches	Feet	Inches	Anthraxylon	Translucent attritus	Opaque attritus	Fusain
266	9	6	3	50.2	43.5	4.7	1.6
394	8	16	2	50.8	41.8	5.5	1.9
447	2	6	10	49.3	47.5	2.6	.6
458	6	4	11	54.2	43.2	2.1	.5
570	0	9	9	48.5	47.5	2.6	1.4
598	8	11	3	47.8	46.9	3.9	1.4
652	9	3	8	52.6	45.9	1.2	.3
670	3	3	1	59.3	38.6	1.6	.5
Total thickness of coal		61	11				

An assembled photograph of the split face of the core through the entire 16-feet 2-inch coal bed found at the depth of 394 feet 8 inches (see table 2) is shown in figures 12 and 13. The banded character of the coal can be readily seen by examining closely the photograph which shows a considerable surface of coal in clear detail.

Four column samples of bituminous coal from Illinois and Missouri and two samples of lignite were analyzed microscopically to determine the petrographic composition and evaluate these coals for use in hydrogenation tests. Significant data from the microscopic analysis are given in table 3. The relative amounts of anthraxylon plus translucent attritus and opaque matter plus fusain are important because it has been experimentally demonstrated that anthraxylon and translucent attritus give much higher yields in hydrogenation than the opaque matter and fusain in coal.

Petrographic analyses by means of particle identification and count under the low-power microscope were made of certain float-and-sink fractions prepared from Illinois No. 6 coal, Bankston Creek Collieries, Sahara No. 6 mine in connection with a coal-preparation study. The content of anthraxylon, bright attritus, dull attritus, fusain, and free mineral matter was determined in 16 float-and-sink fraction samples. The analyses showed a definite relationship between specific gravity of the float and the percentage of coal components present. Pertinent data from the analyses are presented in graphic form in figure 14.

Figure 12. - 8-inch coal core split along natural fracture planes, 16 feet 2 inches thick, from drill hole 5-33, Paonia, Gunnison County, Colo. (See also figure 13.)

Figure 13. - 8-inch coal core split along natural fracture planes, 16 feet 2 inches thick, from drill hole 5-33, Paonia, Gunnison County, Colo. (Continuation of figure 12.)

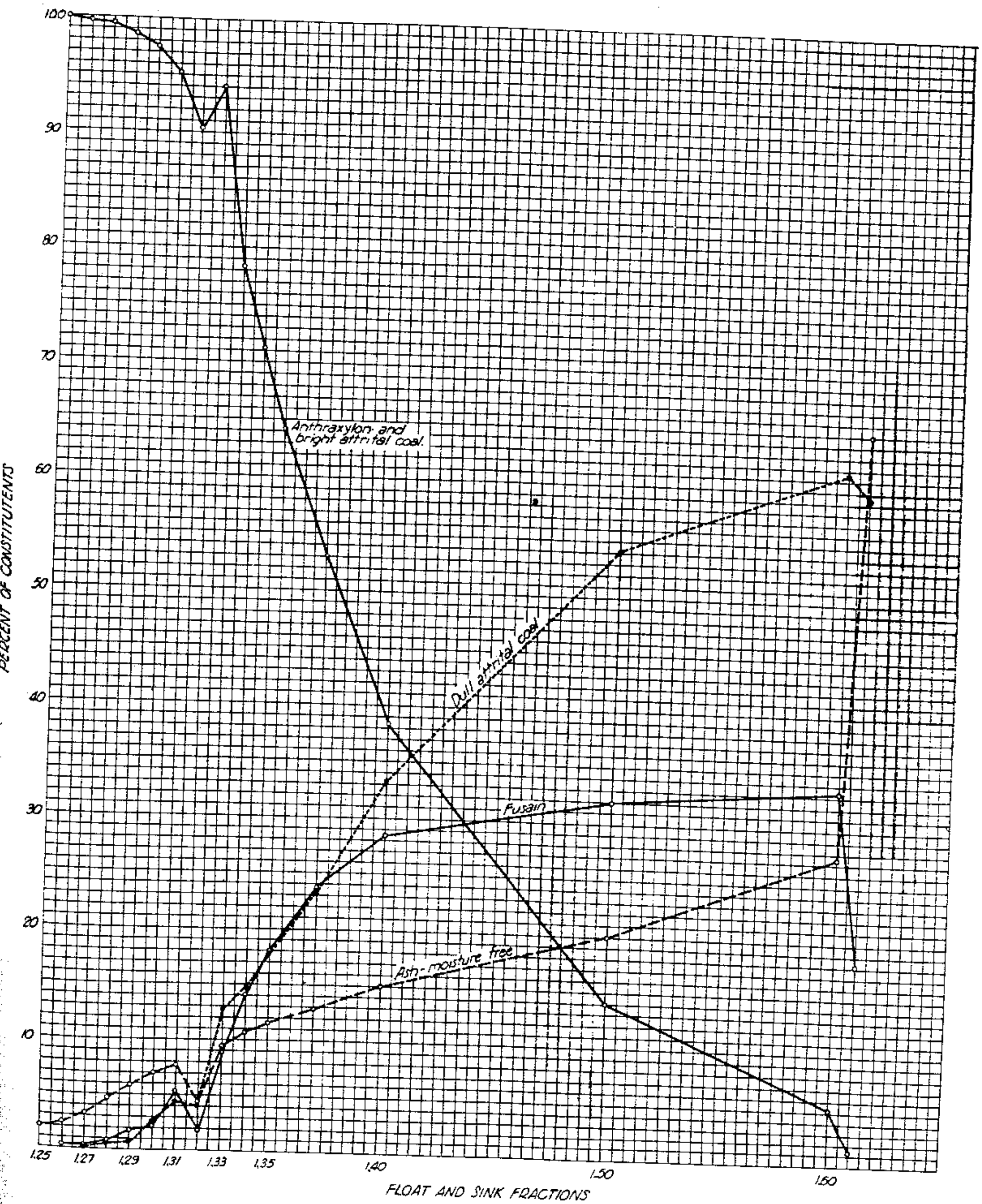

Figure 14. - Percentage of petrographic constituents of float-and-sink fractions, Sahara No. 6 mine, No. 6 bed, Illinois.

TABLE 3. - Petrographic analyses of coal-column samples, percent

Petrographic components	No. 6 Coal Fulton Co., Illinois	No. 6 Coal Macoupin Co., Illinois	No. 5 Coal Sangamon Co., Illinois	Bevier Coal Macon Co., Missouri	Beulah Lignite Mercer Co., N. Dak.	Lehigh Lignite Stark Co., N. Dak.
Anthraxylon	77.2	74.7	72.2	60.5	53.4	59.6
Translucent attritus	17.2	15.7	20.5	30.6	25.1	36.0
Total anthraxylon plus translucent attritus	94.4	90.4	92.7	91.1	78.5	95.6
Opaque attritus	3.9	3.6	5.7	3.5	15.4	2.7
Fusain	1.7	6.0	1.6	5.4	6.1	1.7
Total opaque attritus plus fusain	5.6	9.6	7.3	8.9	21.5	4.4
Thickness of coal	4 ft. 2 in.	7 ft. 7 in.	5 ft. 2 in.	4 ft. 2 in.	10 ft. 9 in.	6 ft. 4 in.